

REMARKS

This is intended as a full and complete response to the Office Action dated May 3, 2006, having a shortened statutory period for response set to expire on August 3, 2006.

CLAIMS

REJECTION UNDER 35 U.S.C. § 102

Claims 1-2, 8-11, 21-24, 30-33, 36-40, 43-44, 53 and 58 stand rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 6,218,959 B1 to Harrison C. Smith (*Smith '959*).

Smith '959 discloses a logging-while-drilling (LWD) or measurement-while-drilling (MWD) downhole repeater system for communicating information between surface equipment and downhole equipment. Information is transmitted from sensors 40 by a transmitter 44 in the form of electromagnetic wave fronts 46 propagated through the earth formation penetrated by a borehole. A receiver 48 of a repeater 34 picks up the wave fronts 46. A current is induced only within the repeater 48 by the wave fronts 46. The current carries response information indicative of the response of the sensors 40. This current is processed by an electronics package 50 within the repeater and forwarded to a transmitter 52 within the repeater that radiates electromagnetic wave front 54 back into the earth to be received by another repeater disposed axially along a drill string 30 (see Col. 4, lines 20-50). It is noted that *Smith '959* teaches the transmission of sensor information to the surface of the earth via electromagnetic wave fronts propagating through earth formation material. The repeaters function only to boost the electromagnetic wave fronts.

As mentioned above, each receiver and transmitter element of a repeater 76 of the system is contained within an isolation subassembly such as shown at 94 of Fig. 2B. The isolation subassembly is electrically isolated from joints of drill pipe by dielectric material (e.g. 96, 106, 108, etc (see Col. 7, lines 13-67).

Referring to Fig. 5 and the related discussion, a toroid 180 may serve as a receiver such as 48, 49, 86, 120, 374 and as a transmitter such as 44, 52, 53, 60 and 124 (see Col. 11, lines 39-43). Both transmitters and receivers of the *Smith '959* repeaters are mounted in a wall of the repeater subassembly, as clearly shown in all pertinent drawings and the related discussion. Stated another way, if a toroid is used as a receiver, it does not surround the drill string. Conversely, the toroid is wound around a permeable annular core 182 as shown in Fig. 5, which in turn is disposed within the wall of the isolation subsection.

The instant invention comprises an electromagnetic (EM) telemetry system embodied in a MWD or LWD system. A downhole assembly 10 comprises an EM transmitter 12 that creates a "signal" current 21 in a drill string 25, wherein the signal current is representative of a response of a downhole sensor 14. It is well known in the art that a drill string 25 comprises sections or "joints" of *drill pipe* (e.g. see *Smith '959* starting at Col. 1, lines 49-58 in the BACKGROUND OF THE INVENTION section). The EM transmitter 12 of the instant invention cooperates with the sensor 14 to modulate the signal current as a function of a parameter of interest measured in a well borehole. A receiver, which is remote from the downhole assembly and located typically at the surface of the earth (see next to last sentence in the SUMMARY OF THE INVENTION section), senses the signal current and is demodulated to obtain a signal indicative of the parameter of interest.

Features of the instant system and the *Smith '959* system are briefly summarized as follows:

(1) The instant invention transmits information from a downhole sensor to (or near) the surface of the earth via a modulated signal *current* that flows *within the drill string* or, more specifically, within joints of *drill pipe* comprising the drill string. The *Smith '959* system transmits information from a downhole sensor to the surface of the earth via electromagnetic (EM) *wave fronts* propagating through *earth formation*.

(2) The instant invention does not use or require any type of repeaters in the transmission of the modulated signal current since it is "hard wired" to the remote or uphole receiver by joined sections of drill pipe comprising the drill string. The *Smith*

'959 system utilizes repeaters, inserted in the drill string *between* joints of drill pipe, to enhance propagated wave front signals that are eventually received at the earth surface.

(3) In the instant invention, the modulated signal current is induced in the downhole end of the drill string by a *sensor cooperating with a transmitter*. In the *Smith '959* system, a current is induced by an EM *wave front* impinging upon the receiver element *of the repeater*. This current is subsequently converted, *within the isolation subassembly containing the repeater*, back to an EM wave front to be received by another repeater and eventually by a receiver at the surface of the earth. Stated another way, the *Smith '959* system does *not* induce a measured *current* that flows up the drill string, or more specifically, does not create a current in *drill pipe*.

(4) The instant invention demodulates the signal current, which flows *directly* from the downhole sensor and cooperating transmitter, to determine a parameter of interest. The *Smith '959* system processes EM wave front radiation, which has propagated through earth formation, to obtain a borehole environs parameter of interest. Furthermore, the propagated EM signal has passed through one or more repeaters. The *Smith '959* system can *not* transmit any current from the downhole sensor because each repeater subassembly acts as an *electrical insulator* within the drill string.

Independent claims 1 and 23 have been amended to recite the detection of a modulated current flowing in a *drill pipe*. Independent claims 10, 16, 32, 38, 53 and 58 have been amended to clearly recite that a detected signal is obtained by demodulating a modulated signal *current* that flows via the *drill string* and *from a sensor generating the signal*, wherein the sensor cooperates with a transmitter. Amended claims 1, 10, 16, 23, 32, 38, 53 and 58 are clearly distinguished over *Smith '959*. Claims 2, 8, 9 that depend upon claim 1, claims 11, 14, 15 that depend upon claim 10, claims 17, 18, 21, 22 that depend upon claim 16, claims 24, 30, 31 that depend upon claim 23, claims 33, 36, 37 that depend upon claim 32, and claims 39, 40, 43 that depend on claim 38, are now also distinguished over *Smith '959*.

In view of the claim amendments and the above discussion, the Examiner is respectfully requested to reconsider rejection of claims 1-2, 8-11, 21-24, 30-33, 36-40, 43-44, 53 and 58 under 35 U.S.C. § 102(b) as being anticipated by *Smith '959*.

REJECTION UNDER 35 U.S.C. § 103

In order to establish a case of *prima facie* obviousness, three basic criteria must be met (MPEP § 2141):

1. There must be some suggestion or motivation, either in the reference(s) themselves or in the knowledge, generally available to one of ordinary skill in the art, to modify the reference(s) or to combine the reference teachings;
2. There must be a reasonable expectation of success; and
3. The prior art must teach or suggest all of the claim limitations. The teachings or suggestions to make the claimed combination and the reasonable expectation of success must both be found in the prior art, not in the applicant's disclosure.

Claims 6, 28 and 42 stand rejected under 35 U.S.C. §103(a) as being unpatentable over *Smith '959*. Applicant respectfully traverses the rejections.

In view of the above discussion, there would be no *motivation* to combine *Smith '959*, which teaches an EM *wave front propagation* telemetry system, with the instant invention which teaches the flow of *modulated drill string current*. Recall that the instant invention provides a *direct* electrical connection (i.e. the drill string comprising electrically connected joints of drill pipe) between a downhole sensor and a receiver disposed at or near the surface of the earth. The isolation subsections housing the repeaters of the *Smith '959* system, disposed *between* sections of drill *pipe*, prevent the drill *string* from acting as a direct current conductor. Any combination of the basic concepts of the instant invention with the *Smith '959* system would, therefore, *lack any reasonable expectation for success*. Two of the three criteria for establish a case of *prima facie* obviousness are *not* met in any hypothetical combination of the instant system with the *Smith '959* system.

In view of the above discussion, and considering previously discussed amendments of base claims upon which they depend, the Examiner is respectfully

requested to reconsider the rejection of claims 6, 28 and 42 under 35 U.S.C. §103(a) as being unpatentable over *Smith '959*.

Claims 4, 13, 20, 26, and 35 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Smith '959* as applied to claims 1, 10, 16, 23 and 32 above, and further in view of U.S Patent No. 6,781,520 B1 to Harrison C. Smith et al (*Smith '520*). Applicant respectfully traverses the rejections.

As discussed in detail above, *Smith '959* discloses a LWD or MWD downhole repeater system for communicating information between surface equipment and downhole equipment. Information is transmitted from sensors 40 by a transmitter 44 in the form of electromagnetic wave fronts 46 propagated through the earth formation penetrated by a borehole. A receiver 48 of a repeater 34 picks up the wave fronts 46. A repeater current is induced within the receiver 48 by the wave fronts 46. The repeater current carries response information indicative of the response of the sensors 40 only within the repeater. This repeater current is processed by an electronics package 50 and forwarded to a transmitter 52 that radiates electromagnetic wave front 54 into the earth to be received by a plurality of additional receivers spaced axially along a drill string 30. As noted previously, *Smith '959* teaches the transmission of sensor information to the surface of the earth via electromagnetic wave fronts propagating through earth formation material. *Smith '959* does not teach or suggest the use of a modulated signal current flowing from a downhole sensor-transmitter system to a remote receiver.

Smith '520 discloses a motion sensor for noise cancellation in a borehole electromagnetic telemetry system. A signal transmitted from a downhole sensor to a surface receiver via an EM signal propagating through earth material. Details of this EM telemetry methodology are summarized at Co. 3, line 48 through Col. 4, line 14. *Smith '520* does not teach or suggest the transmission of a modulated current signal up a drill string.

As discussed previously, the *Smith '959* system can not be embodied to transmit a modulated current signal up a drill string because of the electrical insulating properties of the repeater isolation sub assemblies. The *Smith '520* system utilizes, like the *Smith '959* system, EM wave front propagation through earth formation as a means for telemetering

a signal from a downhole sensor to the surface of the earth. No combination of the *Smith '959* and the *Smith '520* system would yield the element of a drill string data conduit by which a modulated current signal can be transmitter from a downhole sensor to a remote receiver at or near the surface of the earth. Any combination of *Smith '959* and *Smith '520* fails to meet the third criteria for establishing a case of *prima facie* obviousness.

In view of the above discussion, and considering previously discussed amendments of base claims upon which they depend, the Examiner is respectfully requested to reconsider the rejection of claims 4, 13, 20, 26, and 35 under 35 U.S.C. § 103(a) as being unpatentable over *Smith '959* as applied to claims 1, 10, 16, 23 and 32 above, and further in view of *Smith '520*.

Claims 5, 7, 27, 29, 49-52 and 54-57 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Smith '959* in view of U.S. Patent No. 6,727,827 B1 to John E. Edwards et al (*Edwards et al*). Applicant respectfully traverses the rejections.

To summarize once again, *Smith '959* discloses a LWD or MWD downhole repeater system for communicating information between surface equipment and downhole equipment. Information is transmitted from sensors 40 by a transmitter 44 in the form of electromagnetic wave fronts 46 propagated through the earth formation penetrated by a borehole. A receiver 48 of a repeater 34 picks up the wave fronts 46. A repeater current is induced in the receiver 48 by the wave fronts 46. The repeater current carries response information indicative of the response of the sensors 40. This current is processed by an electronics package 50 and forwarded to a transmitter 52 that radiates electromagnetic wave front 54 into the earth to be received by a plurality of additional receivers spaced axially along a drill string 30. *Smith '959* teaches the transmission of sensor information to the surface of the earth via electromagnetic wave fronts propagating through earth formation. *Smith '959* does not teach or suggest the use of a modulated signal current flowing from a downhole sensor-transmitter system to a remote receiver.

Edwards et al discloses a MWD drilling electromagnetic telemetry system using fixed downhole receivers. All telemetry transmission taught by *Edwards et al* is EM propagation through earth formation. Toroids and current flowing therein are used as

means for coupling coaxial strings of tubing. *Edwards et al* nowhere teaches of suggests the use of a modulated signal current flowing, within a drill string, from a downhole sensor to a remote receiver disposed at or near the surface of the earth. No combination of the *Smith '959* and the *Edwards et al* systems would yield the element of a drill string data conduit through which a modulated current signal can flow directly from a downhole assembly to a remote receiver at or near the surface of the earth. Any combination of *Smith '959* and *Edwards et al* fails, therefore, to meet the third criteria for establishing a case of *prima facie* obviousness.

In view of the above discussion, and considering the claim amendments, the Examiner is respectfully requested to reconsider the rejection of claims 5, 7, 27, 29, 49-52 and 54-57 under 35 U.S.C. § 103(a) as being unpatentable over *Smith '959* in view of *Edwards et al.*

ALLOWABLE MATERIAL

The Examiner states that claims 3, 12, 19, 25, 34 and 41 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Claims 3, 12, 19, 25, 34 and 41 have been rewritten as independent claims and now meet the Examiner's stated criteria for allowability. The Examiner is respectfully requested to allow amended claims 3, 12, 19, 25, 34 and 41.

ALLOWED CLAIMS

Applicant gratefully acknowledges the allowance of claims 45-48.

SUMMARY

In view of the above discussion and amendments to the claims, the Examiner is respectfully requested to reconsider all rejections and allow claims 1-44, 49-58.